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(54) **CERAMIC TOOL FOR CUTTING VERY HARD MATERIAL**

(57)Abstract:
PURPOSE: To improve the abrasion resistance against a very hard material when the material is cut and worked at high speed, and to restrict peeling of a coating film by specifying the average particle size of the composition particle of a ceramic main body, and by specifying the thickness of the coating film.
CONSTITUTION: A ceramic tool comprises a sintered body, for which a sintered material and a sintering assistant are mixed together and sintered, and at least one layer coating film to be formed on the surface of the sintered body. The average particle size of the overall composition forming the sintered body is no more than 1μm, and the sintered material comprises 90-50wt.% of powder of Al2O3 composition and 10-50wt.% of at least one type of powder of carbide, nitride or carbonitride of elements belonging to IVa, Va, and VIa groups, where the overall amount is considered to be 100wt.%. The amount of the sintering assistant is 0.2-5.0wt.% to 100wt.% of sintered material, while the coating film comprises carbide, nitride, carbonitride of elements belonging to IVa, Va, VIa groups. Al2O3 or AlON, and each layer is no more than 2μm in thickness, and the entire thickness is 0.2-20μm.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention is excellent in abrasion resistance, a mechanical strength, etc., and relates to the ceramic tool which can be used for high-speed-cutting processing of high degree-of-hardness material, such as a carburization hardened steel, a die steel, and tool steel.
[0002]
[Description of the Prior Art] Although the grinding process of the high degree-of-hardness material, such as a carburization hardened steel, a die steel, and tool steel, has been conventionally carried out by the grinding stone, in order that it may raise processing efficiency and may process it more at high speed, shift is achieved to cutting by a ceramic tool or CBN tools, such as an alumina-titanium-carbide system. However, an alumina-titanium-carbide system ceramic tool has a short life, and it cannot respond to improvement in the speed of cutting a top lacking in reliability, but, recently, a CBN tool is used in many cases. However, although a CBN tool is excellent in cutting-ability ability, it is very expensive, and is cheap among users, and its voice which desires development of the ceramic tool which has the high performance which is equal to a CBN tool is high in especially high-speed-cutting processing.
[0003] With the technology which the various attempts for improving the abrasion resistance and deficit-proof nature of a ceramic tool, such as an alumina-titanium-carbide system, are made there, and was indicated by JP,4-114955,A By calcinating the raw material powder which blended detailed powder, such as a zirconium oxide, with the detailed powder of an alumina, the technology of improving abrasion resistance is indicated by preparing the covering film which is aiming at improvement in intensity and toughness, and becomes JP,4-289002,A and JP,5-69205,A from the carbide of the alloy of an alumina, a titanium carbide, titanium, and aluminum etc. on the front face of a ceramic base material. Although those cutting tools are excellent in performances, such as abrasion resistance, compared with the conventional ceramic tool, a CBN tool is not attained to especially in high speed cutting, but cutting in high speed is expected development of an usable ceramic tool.
[0004]
[Problem(s) to be Solved by the Invention] this invention solves the above-mentioned trouble and makes it a technical problem to offer the ceramic tool for cutting which can be used for cutting of high degree-of-hardness material in high-speed-cutting processing which is equal to the cutting conditions of a CBN tool.
[0005]
[Means for Solving the Problem] The ceramic tool for high degree-of-hardness material cutting of **** 1 invention In the ceramic tool for cutting which consists of a sintered compact which mixes and comes to calcinate a sintering raw material and a sintering acid, and a covering film of at least one layer formed in the above-mentioned sintering body surface The mean particle diameter of all the components that constitute the above-mentioned sintered compact is 1 micrometer or less. the above-mentioned sintering raw material When the whole quantity is made into 100 % of the weight, it is 90 - 50% of the weight of aluminum 2O3. Component powder, It consists of one or more sorts of powder of the carbide of 10 - 50% of the weight of IVa, Va, and a VIa group element, a nitride, and a charcoal nitride. the above-mentioned sintering acid It is 0.2 - 5.0 % of the weight to the 100 % of the weight of the above-mentioned sintering raw materials. moreover, the above-mentioned covering film The carbide of IVa, Va, and a VIa group element, a nitride, a charcoal nitride, and aluminum 2O3 Or it is characterized by consisting of AlON, and for the thickness of each class being 2 micrometers or less, and total thickness being 0.2-10 micrometers.
[0006] The 2nd invention is characterized by for the mean particle diameter of all the components that constitute the above-mentioned sintered compact being 0.7 micrometers or less, and the thickness of each class of the above-mentioned covering film being 1 micrometer or less. moreover, the 3rd invention Above aluminum 2O3 Component powder is 95 - 50% of the weight of aluminum 2O3, when the whole quantity is made into 100 % of the weight. Powder and 5 - 50% of the weight of ZrO2 It is characterized by the bird clapper from powder. Furthermore, the 4th invention is characterized by being a layer with a thickness of 1 micrometer or less which the above-mentioned covering film becomes from two or more layers, and an innermost layer becomes from aluminum 2O3 or AlON, and being a layer with a thickness of 0.5 micrometers or less which an outermost layer of drum becomes from TiN, and the ceramic tool of the 5th invention is characterized by the amount of average flank wear measured according to the specific test condition indicated to the claim 5 being 0.2mm or less.
[0007] The above "a sintering raw material" consists of the "aluminum2O3 component powder" and "one or more sorts of powder of the carbide of IVa, Va, and a VIa group element, a nitride, and a charcoal nitride" (henceforth "powder, such as a titanium

carbide,") which are principal components. As "powder, such as a titanium carbide,", the powder of the carbide of VIa group elements, such as Va group elements, such as IVa group elements, such as titanium and a zirconium, vanadium, and a tantalum, and chromium, and a tungsten, a nitride, and a charcoal nitride can be used, and, specifically, powder, such as a titanium carbide, a titanium nitride, a tantalum carbide, and a tungsten carbide, is mentioned. Powder, such as these titanium carbides, may use one kind, and may use two or more sorts together.

[0008] When the whole quantity of a sintering raw material is made into 100 % of the weight, the mixed rate of each above-mentioned component is "aluminum2O3 component powder is 90 - 50 % of the weight", and is "powder, such as a titanium carbide, is 10 - 50 % of the weight." aluminum 2O3 The mean particle diameter of all the components from which the rate of component powder constitutes a sintered compact exceeding 90 % of the weight when high becomes large exceeding 1 micrometer, and anti-**** which is the index of toughness declines. Moreover, less than 50 % of the weight is not enough as precise-izing of a sintered compact, relative density becomes small, and anti-**** is also aluminum 2O3. It falls further from the case where component powder exceeds 90 % of the weight. Moreover, the above aluminum 2O3 Component powder is ZrO2 even about the amount of halves. By transposing to powder, it is aluminum 2O3. Growth of a particle is suppressed, and if it is the combination which other component and its amount approximated, the degree of hardness and anti-**** of a sintered compact can be raised further. However, the amount of halves is exceeded and it is ZrO2. When it transposes to powder, since the mechanical strength of sintered compacts, such as anti-****, falls, it is not desirable.

[0009] As the above "a sintering acid", a magnesium oxide, a calcium oxide, oxidization silicon, nickel oxide, a chrome oxide, an oxidization dysprosium, a yttrium oxide, etc. are mentioned, and it can be used, without restricting especially these. Especially a magnesium oxide is [an effect which inhibits the crystal growth of an alumina] and is desirable. In this invention, a sintering acid is used 0.2 to 5.0% of the weight to 100 % of the weight of sintering raw materials. When the amount of the sintering acid used is less than 0.2 % of the weight, while precise-izing of a sintered compact is not enough and relative density falls greatly, a degree of hardness and anti-**** also decline greatly. Moreover, exceeding 5.0 % of the weight, when many, the mean particle diameter of all the components that form a sintered compact becomes large, and it becomes that in which anti-**** etc. declined and toughness was inferior. Especially the amount of the sintering acid used has 0.5 - 1.5% of the weight of a desirable range, and if it is this range, it will become that in which a degree of hardness, anti-****, etc. were more excellent. in addition, the range whose particle size is 0.3-1.2 micrometers in this invention although all the particles that constitute a sintered compact have a more detailed desirable thing -- a mean particle diameter -- a thing 1.0 micrometers or less -- a mean particle diameter can use particle size] a thing 0.7 micrometers or less by 0.3-1.0 micrometers preferably especially

[0010] aluminum 2O3 besides the carbide of the IVa same as a raw material which forms the above "a covering film" as the component which constitutes the above-mentioned sintered compact, Va, and a VIa group element, a nitride, and a charcoal nitride, and AlON are mentioned, these are excellent in compatibility with a sintered compact, and a covering film does not exfoliate from a sintering body surface, and a degree of hardness is high, and since it excels in abrasion resistance etc., it is desirable. Although there should just be at least one layer of covering films, it is desirable that 2 micrometers or less of thickness of each class are especially 1 micrometer or less, and it is what total thickness becomes from two or more layers 0.2-10 micrometers or less, and when the thickness of each class was the above thin layers and it is used for high-speed cutting, a covering film does not exfoliate. moreover, an innermost layer -- aluminum 2O3 with a thickness of 1 micrometer or less or -- if an AlON layer and an outermost layer of drum form the covering film which consists of a titanium-nitride layer with a thickness of 0.5 micrometers or less -- aluminum 2O3 While excelling in compatibility with the sintered compact made into a subject, surface hardness is very high, and the ceramic tool which has a front face without a grain-boundary glass phase is obtained, and it is more desirable.

[0011]

[Function] When cutting high degree-of-hardness material, such as a carburization hardened steel and a die steel, and carrying out cutting especially at high speed, it becomes the elevated temperature of 1000 degrees C or more partially. Therefore, since the rapid fall of a degree of hardness, intensity, etc. takes place in the usual ceramic tool, and intense wear is produced or a loss is suffered depending on the case, a tool life is short. In this invention, by combining the sintering acid of the amount of specification with a specific sintering raw material, 1 micrometer or less of mean particle diameters of the component particle of most which constitutes an organization can be preferably set to 0.7 micrometers, and an alumina system sintered compact with very high degree of hardness and intensity can be obtained. Moreover, when the thickness of each class forms preferably 2 micrometers or less of covering films 1 micrometer or less of at least one layer in the front face of this sintered compact, it excels in the adhesion to a base material, and can consider as a ceramic suitable as an object for the cutting tools of the high degree-of-hardness material which has large covering films, such as a degree of hardness and intensity. Furthermore, when exposed to an elevated temperature in the above high speed cutting, even if a high degree of hardness and high intensity are maintained and the cutting tool which used the ceramic which consists of the sintered compact and covering film of this invention is the above cutting speed by 150mm/which is the cutting-speed region of a CBN tool, it is usable enough.

[0012]

[Example] Hereafter, an example and the example of comparison explain this invention concretely.

(1) Manufacture ** aluminum 2O3 of a sintered compact Component: aluminum 2O3 of 0.5 micrometers of mean particle diameters ZrO2 of powder and 0.5 micrometers of mean particle diameters TiC of 1 micrometer of :mean particle diameters, such as powder and a ** titanium carbide, TiCN, TaC, WC powder, a ** sintering acid: MgO of 0.2 micrometers of mean particle diameters, Y2O3 of 0.9 micrometers of mean particle diameters, and Dy2O3 Powder and each above component. It mixed at a

rate shown in Table 1 (operation article) and 2 (comparison article), and after strong-grinding by attritor, the hotpress was carried out at pressure 200 kg/cm2 and the temperature of 1700-1800 degrees C. The grinding process of the obtained sintered compact was carried out to the predetermined configuration, and the chip for a cutting test was produced (the operation article 2, 4, 5, and 7 is used). Moreover, the mean particle diameter of a sintered compact, relative density, a degree of hardness (measuring method : Vickers hardness and load 10 Kgf), and anti-**** (measuring method : JISR- 1601 conformity) were measured by the piece of a trial started from the above-mentioned sintered compact. Those results are shown in Tables 1 and 2 (each inside hyperventilation of ** expresses the above-mentioned degree of hardness). in addition, the table 2 -- setting -- * -- numerical limitation -- a thing out of range is expressed

[0013]

[Table 1]

表 1

実施品	焼結原料（重量%）		焼結助剤（重量%）	平均粒子径（μm）	相対密度（%）	HV（kg/mm²）	抗折力（kg/mm²）
	Al_2O_3	その他					
1	85	TiC 15	MgO 1.0	0.7	99.5	2040	108
2	70	TiC 30	MgO 1.0	0.5	99.5	2150	113
3	55	TiC 45	MgO 1.0	0.4	99.2	2130	98
4	70	TiCN 30	MgO 1.0	0.4	99.6	2110	121
5	70	TiC + TaC 15 15	MgO 1.0	0.5	99.8	2180	124
6	70	TiC + WC 15 15	MgO 1.0	0.5	99.5	2090	113
7	70	TiC 30	MgO + Dy_2O_3 0.5 0.5	0.4	99.8	2210	131
8	70	TiC 30	MgO 4.0	0.9	99.8	1980	96
9	70	TiC 30	MgO 2.0	0.8	99.8	2030	103
10	55 + $ZrO_2$15	TiC 30	MgO 2.0	0.5	99.7	1950	108

[0014]

[Table 2]

表 2

比較品	焼結原料（重量%）		焼結助剤（重量%）	平均粒子径（μm）	相対密度（%）	HV（kg/mm²）	抗折力（kg/mm²）
	Al_2O_3	その他					
1	* 95	TiC 15	MgO 1.0	1.5	99.9	1870	95
2	* 45	TiC 55	MgO 1.0	0.4	98.5	1830	74
3	70	TiC 30	MgO * 0.1	0.5	89.9	1560	52
4	70	TiC 30	MgO * 6.0	1.3	99.9	1740	84
5	15+ZrO_2 * 55	TiC 30	MgO 2.0	0.5	98.9	1710	97

[0015] As for the sintered compact used for the ceramic tool of this invention, according to the result of Table 1, it turns out that all are 1 micrometer or less and relative density is [a degree of hardness and anti-****] excellent for the mean particle diameter of all the components at 99 % of the weight or more and the high top. When especially the amount of the sintering acid used is 1 % of the weight, compared with the case where the amount used is 2 % of the weight or more, it excels further. according to the

result of Table 2 on the other hand -- aluminum 2O3 or the case (comparison article 3) where the mean particle diameter of all the components of a sintered compact exceeds 1 micrometer, and a degree of hardness and anti-**** are inferior, and MgO is under a minimum when MgO exceeds an upper limit (comparison article 1 and 4) -- relative density, a degree of hardness, and anti-**** -- any -- although -- it turns out that it is falling greatly Also in the case of others, a degree of hardness and anti-**** decline, and no comparison articles can be used as a sintered compact for obtaining the ceramic tool of this invention.
[0016] (2) The manufacture above of a ceramic tool (1) The covering film shown in Tables 3 (example) and 4 (example of comparison) was formed in the produced chip front face for a cutting test by well-known CVD or well-known PVD, and the cutting test was carried out on the following conditions.
** **-ed material: -- SCN415 carburizing material (Hv=850-700 Kg/mm2) ** chip configuration: -- TNGN332 ** cutting-speed: -- after having ** sent by 200m/, :0.1 mm/rev** cutting deeply and cutting **-ed material for 30 minutes on the :0.3mm** chamfer:0.2mmx-25-degree above-mentioned conditions, the amount of average flank wear (the amount of VB wear) was measured Those results are shown in Tables 3 and 4. in addition, the table 4 -- setting -- * -- numerical limitation -- a thing out of range is expressed
[0017]
[Table 3]

表 3

実施例	使用焼結体実施品No	被覆膜種類及び厚さ（μm）内層～外層	全厚さ（μm）	V_B 磨耗量（mm）	剥離の有無
1	2	Al_2O_3(0.2)+TiC(0.1)	0.3	0.18	なし
2	2	Al_2O_3(0.8)+TiC(0.8) ×5 層	8.0	0.17	なし
3	2	Al_2O_3(0.7)+TiC(0.7)+TiN(0.2)	1.6	0.15	なし
4	2	TiC(0.7)+ Al_2O_3(0.7)	1.4	0.17	なし
5	2	Al_2O_3(1.5)+TiC(0.7)	2.2	0.16	なし
6	2	Al_2O_3(0.7)	0.7	0.18	なし
7	2	TiC(0.7)	0.7	0.15	なし
8	2	TiN(0.7)	0.7	0.17	なし
9	4	Al_2O_3(0.7)+TiC(0.7)+TiN(0.2)	1.6	0.16	なし
10	5	Al_2O_3(0.7)+TiC(0.7)+TiN(0.2)	1.6	0.15	なし
11	7	Al_2O_3(0.7)+TiC(0.7)+TiN(0.2)	1.6	0.15	なし
12	2	Al_2O_3(0.7)+AlON(0.7)+TiN(0.7)	2.1	0.17	なし

[0018]
[Table 4]

表 4

比較例	使用焼結体実施品No	被覆膜種類及び厚さ（μm）内層～外層	全厚さ（μm）	V_B 磨耗量（mm）	剥離の有無
1	2	Al_2O_3(0.05)+TiC(0.05)	*0.1	0.30	なし
2	2	Al_2O_3(0.8)+TiC(0.8) ×7 層	*11.2	0.32	剥離大
3	2	Al_2O_3(*3.0)+TiC(0.7)	3.7	0.32	剥離
4	市販品	TiN(1.0)(PVDｺｰﾃｨﾝｸﾞ)	1.0	0.40	剥離、折損

[0019] According to the result of Table 3, a covering film does not exfoliate [in / the high speed cutting of high degree-of-hardness material / each], and the ceramic tool of this invention is VB. It turns out that the amount of wear is small. Moreover, it is aluminum 2O3 with a thickness of 0.7 micrometers to an innermost layer. Especially when the case of the covering film which used TiN with a thickness of 0.2 micrometers for the outermost layer of drum, and a covering film are TiC(s), it turns out that it excels in abrasion resistance. Each thing (example 3 of comparison) to which the thing (example 2 of comparison) and the thickness of one layer in which the total thickness of a covering film exceeded the thing (example 1 of comparison) of under a minimum and the upper limit exceeded the upper limit on the other hand according to the result of Table 4 is VB. The amount of wear is about twice, and ablation of a covering film is also produced in the examples 2 and 3 of comparison, and a surface-of-separation product is especially large in the example 2 of In addition, in the commercial elegance which carried out the cutting test similarly as an example 4 of comparison for reference, it turns out that there are still more amounts of wear, and they produce not only ablation but breakage of a chip, and are inferior to the example of comparison in this invention in a performance remarkably compared with the ceramic tool of this invention.

[0020]

[Effect of the Invention] The mean particle diameter of the constituent particle of a ceramic main part is a specific minute particle, and since it has the covering film of specific thickness, the outstanding degree of hardness and intensity are maintained, and the ceramic tool for high degree-of-hardness material cutting of this invention can be used as substitution of a CBN tool, when it excels in a degree of hardness and intensity and cutting of the high degree-of-hardness material, such as a carburization hardened steel and a die steel, is carried out at high speed.

[Translation done.]

* NOTICES *

CLAIMS

[Claim(s)]

[Claim 1] The sintered compact which mixes and comes to calcinate a sintering raw material and a sintering acid. The covering film of at least one layer formed in the above-mentioned sintering body surface. It is the ceramic tool for high degree-of-hardness material cutting equipped with the above, and the mean particle diameter of all the components that constitute the above-mentioned sintered compact is 1 micrometer or less. the above-mentioned sintering raw material When the whole quantity is made into 100 % of the weight, it is 90 - 50% of the weight of aluminum 2O3. Component powder, It consists of one or more sorts of powder of the carbide of 10 - 50% of the weight of IVa, Va, and a VIa group element, a nitride, and a charcoal nitride. the above-mentioned sintering acid It is 0.2 - 5.0 % of the weight to the 100 % of the weight of the above-mentioned sintering raw materials. moreover, the above-mentioned covering film The carbide of IVa, Va, and a VIa group element, a nitride, a charcoal nitride, and aluminum 2O3 Or it is characterized by consisting of AlON, and for the thickness of each class being 2 micrometers or less, and total thickness being 0.2-10 micrometers.

[Claim 2] The ceramic tool for high degree-of-hardness material cutting according to claim 1 characterized by for the mean particle diameter of all the components that constitute the above-mentioned sintered compact being 0.7 micrometers or less, and the thickness of each class of the above-mentioned covering film being 1 micrometer or less.

[Claim 3] Above aluminum 2O3 Component powder is 95 - 50% of the weight of aluminum 2O3, when the whole quantity is made into 100 % of the weight. Powder and 5 - 50% of the weight of ZrO2 Ceramic tool for high degree-of-hardness material cutting according to claim 1 or 2 characterized by the bird clapper from powder.

[Claim 4] The above-mentioned covering film consists of two or more layers, and an innermost layer is aluminum 2O3. Or ceramic tool for high degree-of-hardness material cutting according to claim 1, 2, or 3 characterized by being a layer with a thickness of 1 micrometer or less it is thin from AlON, and being a layer with a thickness of 0.5 micrometers or less which an outermost layer of drum becomes from TiN.

[Claim 5] The ceramic tool for high degree-of-hardness material cutting according to claim 1, 2, 3, or 4 characterized by the amount of average flank wear by the following test condition being 0.2mm or less. test condition [of the amount of flank wear]: -- **-ed material; -- a part for SCN415 carburizing material (Hv=700-850 Kg/mm2) and cutting-speed;250m/-- sending --;0.1 mm/rev -- cutting deeply --;0.3mm and chamfer;0.2mmx-25 degree

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[Translation done.]

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PURPOSE: To improve the abrasion resistance against a very hard material when the material is cut and worked at high speed, and to restrict peeling of a coating film by specifying the average particle size of the composition particle of a ceramic main body, and by specifying the thickness of the coating film.
CONSTITUTION: A ceramic tool comprises a sintered body, for which a sintered material and a sintering assistant are mixed together and sintered, and at least one layer coating film to be formed on the surface of the sintered body. The average particle size of the overall composition forming the sintered body is no more than 1μm, and the sintered material comprises 90-50wt.% of powder of Al2O3 composition and 10-50wt.% of at least one type of powder of carbide, nitride or carbonitride of elements belonging to IVa, Va, and VIa groups, where the overall amount is considered to be 100wt.%. The amount of the sintering assistant is 0.2-5.0wt.% to 100wt.% of sintered material, while the coating film comprises carbide, nitride, carbonitride of elements belonging to IVa, Va, VIa groups. Al2O3 or AlON, and each layer is no more than 2μm in thickness, and the entire thickness is 0.2-20μm.

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(54)【発明の名称】 高硬度材切削用セラミック工具

(57)【要約】

【目的】 硬度、強度等が大きく、高硬度材を高速で切削加工する際の耐磨耗性にも優れ、また、焼結体表面に形成される被覆膜の剥離等を生ずることのないセラミック工具を提供する。

【構成】 平均粒径０．５μｍのAl_2O_3粉末７０重量%、平均粒径１μｍのＴｉＣ粉末３０重量%に、これら２成分の全量に対して１．０重量%のＭｇＯを焼結助剤として加えて混合し、アトライターで強粉砕した後、圧力２００kg/cm^2、温度１７００～１８００℃でホットプレスし焼結体を得る。この焼結体を切削工具用のチップ形状に研削し、この表面にＣＶＤ法或いはＰＶＤ法によって、厚さ０．２μｍのAl_2O_3層（内層）及び厚さ０．１μｍのＴｉＣ層（外層）からなる被覆膜を形成し、高硬度材切削加工用のセラミック工具を得る。

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【特許請求の範囲】

【請求項１】　焼結原料と焼結助剤とを混合し、焼成してなる焼結体と、上記焼結体表面に形成される少なくとも１層の被覆膜とからなる切削用セラミック工具において、

上記焼結体を構成する全成分の平均粒径が１μm以下であり、上記焼結原料は、その全量を１００重量%とした場合に、９０～５０重量%のAl_2O_3成分粉末と、１０～５０重量%のＩＶａ、Ｖａ、ＶＩａ族元素の炭化物、窒化物及び炭窒化物の１種以上の粉末とからなり、上記焼結助剤は、上記焼結原料１００重量%に対して０．２～５．０重量%であり、また、上記被覆膜は、ＩＶａ、Ｖａ、ＶＩａ族元素の炭化物、窒化物、炭窒化物、Al_2O_3又はＡｌＯＮからなり、且つ、各層の厚さが２μm以下であり、全厚さが０．２～１０μmであることを特徴とする高硬度材切削用セラミック工具。

【請求項２】　上記焼結体を構成する全成分の平均粒径が０．７μm以下であり、上記被覆膜の各層の厚さが１μm以下であることを特徴とする請求項１記載の高硬度材切削用セラミック工具。

【請求項３】　上記Al_2O_3成分粉末は、その全量を１００重量%とした場合に、９５～５０重量%のAl_2O_3粉末と５～５０重量%のZrO_2粉末とからなることを特徴とする請求項１又は２記載の高硬度材切削用セラミック工具。

【請求項４】　上記被覆膜が複数の層からなり、最内層がAl_2O_3又はＡｌＯＮからなる厚さ１μm以下の層であり、最外層がＴｉＮからなる厚さ０．５μm以下の層であることを特徴とする請求項１、２又は３記載の高硬度材切削用セラミック工具。

【請求項５】　下記の試験条件による平均逃げ面磨耗量が０．２mm以下であることを特徴とする請求項１、２、３又は４記載の高硬度材切削用セラミック工具。逃げ面磨耗量の試験条件：被削材；ＳＣＭ４１５浸炭焼き入れ材（Hv=700～850 Kg/mm^2）、切削速度；２５０m／分、送り；０．１mm／ｒｅｖ、切込み；０．３mm、チャンファー；０．２mm×－２５°

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、耐磨耗性、機械的強度等に優れ、浸炭焼き入れ鋼、ダイス鋼、工具鋼等の高硬度材の高速切削加工に使用できるセラミック工具に関する。

【０００２】

【従来の技術】浸炭焼き入れ鋼、ダイス鋼、工具鋼等の高硬度材は、従来、砥石により研削加工されてきたが、加工効率を高め、より高速で加工するため、アルミナー炭化チタン系等のセラミック工具或いはＣＢＮ工具による切削加工へと移行が図られている。ところが、アルミナー炭化チタン系セラミック工具は寿命が短く、信頼性

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に乏しいうえ、切削加工の高速化に対応できず、最近ではＣＢＮ工具が使用されることが多い。しかし、ＣＢＮ工具は切削性能には優れるものの、非常に高価であり、ユーザーの間では安価であって、且つ、特に高速切削加工において、ＣＢＮ工具に匹敵する高性能を有するセラミック工具の開発を望む声が高い。

【０００３】そこで、アルミナー炭化チタン系等のセラミック工具の耐磨耗性や耐欠損性を改善するための種々の試みがなされており、特開平４－１１４９５５号公報に記載された技術では、アルミナの微細粉末に酸化ジルコニウム等の微細粉末を配合した原料粉末を焼成することにより、強度、靭性の向上を図っており、また、特開平４－２８９００２号及び特開平５－６９２０５号公報には、セラミック母材の表面にアルミナ、炭化チタン、チタンとアルミニウムとの合金の炭化物等からなる被覆膜を設けることにより、耐磨耗性を改善する技術が開示されている。それらの切削工具は従来のセラミック工具に比べて、耐磨耗性等の性能は優れるものの、特に高速切削においてはＣＢＮ工具には及ばず、高速での切削加工に使用可能なセラミック工具の開発が望まれている。

【０００４】

【発明が解決しようとする課題】本発明は、上記の問題点を解決し、ＣＢＮ工具の切削条件に匹敵する高速切削加工において、高硬度材の切削加工に使用し得る切削用セラミック工具を提供することを課題とする。

【０００５】

【課題を解決するための手段】本第１発明の高硬度材切削用セラミック工具は、焼結原料と焼結助剤とを混合し、焼成してなる焼結体と、上記焼結体表面に形成される少なくとも１層の被覆膜とからなる切削用セラミック工具において、上記焼結体を構成する全成分の平均粒径が１μm以下であり、上記焼結原料は、その全量を１００重量%とした場合に、９０～５０重量%のAl_2O_3成分粉末と、１０～５０重量%のＩＶａ、Ｖａ、ＶＩａ族元素の炭化物、窒化物及び炭窒化物の１種以上の粉末とからなり、上記焼結助剤は、上記焼結原料１００重量%に対して０．２～５．０重量%であり、また、上記被覆膜は、ＩＶａ、Ｖａ、ＶＩａ族元素の炭化物、窒化物、炭窒化物、Al_2O_3又はＡｌＯＮからなり、且つ、各層の厚さが２μm以下であり、全厚さが０．２～１０μmであることを特徴とする。

【０００６】第２発明は、上記焼結体を構成する全成分の平均粒径が０．７μm以下であり、上記被覆膜の各層の厚さが１μm以下であることを特徴とし、また、第３発明は、上記Al_2O_3成分粉末は、その全量を１００重量%とした場合に、９５～５０重量%のAl_2O_3粉末と５～５０重量%のZrO_2粉末とからなることを特徴とする。更に、第４発明は、上記被覆膜が複数の層からなり、最内層がAl_2O_3又はＡｌＯＮからなる厚さ１μm以下の層であり、最外層がＴｉＮからなる厚さ０．５μ

m以下の層であることを特徴とし、第５発明のセラミック工具は、請求項５に記載した特定の試験条件により測定した平均逃げ面磨耗量が０．２mm以下であることを特徴とする。

【０００７】上記「焼結原料」は、主成分である「Al_2O_3成分粉末」と「ＩＶａ、Ｖａ、ＶＩａ族元素の炭化物、窒化物、炭窒化物の１種以上の粉末」（以下、「炭化チタン等の粉末」という）とからなる。「炭化チタン等の粉末」としては、チタン、ジルコニウム等のＩＶａ族元素、バナジウム、タンタル等のＶａ族元素及びクロム、タングステン等のＶＩａ族元素の炭化物、窒化物及び炭窒化物の粉末が使用でき、具体的には、炭化チタン、窒化チタン、炭化タンタル、炭化タングステン等の粉末が挙げられる。これら炭化チタン等の粉末は１種類を用いてもよいし、２種以上を併用してもよい。

【０００８】上記各成分の混合割合は、焼結原料の全量を１００重量%とした場合に、「Al_2O_3成分粉末が９０～５０重量%」であり、「炭化チタン等の粉末が１０～５０重量%」である。Al_2O_3成分粉末の割合が９０重量%を越えて高い場合は、焼結体を構成する全成分の平均粒径が１μmを越えて大きくなり、靭性の指標である抗折力が低下する。また、５０重量%未満では、焼結体の緻密化が十分ではなく、相対密度が小さくなり、抗折力もAl_2O_3成分粉末が９０重量%を越える場合より更に低下する。また、上記Al_2O_3成分粉末は、その半分量までをZrO_2粉末に置き替えることにより、Al_2O_3粒子の成長が抑制され、他の成分及びその量が近似した配合であれば、更に焼結体の硬度及び抗折力を向上させることができる。しかし、半分量を超えてZrO_2粉末に置き替えた場合は、抗折力等焼結体の機械的強度が低下するため好ましくない。

【０００９】上記「焼結助剤」としては、酸化マグネシウム、酸化カルシウム、酸化珪素、酸化ニッケル、酸化クロム、酸化ジスプロシウム、酸化イットリウム等が挙げられ、これらを特に制限されることなく使用できる。特に、酸化マグネシウムはアルミナの結晶成長を抑止する効果があり好ましい。本発明では、焼結助剤は、焼結原料１００重量%に対して０．２～５．０重量%使用する。焼結助剤の使用量が０．２重量%未満の場合は、焼結体の緻密化が十分ではなく、相対密度が大きく低下するとともに、硬度及び抗折力も大きく低下する。また、５．０重量%を超えて多い場合は、焼結体を形成する全成分の平均粒径が大きくなり、抗折力等が低下して靭性の劣ったものとなる。焼結助剤の使用量は、特に０．５～１．５重量%の範囲が好ましく、この範囲であれば硬度、抗折力等がより優れたものとなる。尚、焼結体を構成する全粒子は、より微細であることが好ましいが、本発明では、粒径が０．３～１．２μmの範囲で平均粒径が１．０μm以下のもの、特に好ましくは、粒径が０．３～１．０μmで平均粒径が０．７μm以下のものを使用できる。

【００１０】上記「被覆膜」を形成する原料としては、上記焼結体を構成する成分と同様のＩＶａ、Ｖａ、ＶＩａ族元素の炭化物、窒化物、炭窒化物の他、Al_2O_3、ＡｌＯＮが挙げられ、これらは焼結体との相溶性に優れ、被覆膜が焼結体表面から剥離することがなく、また、硬度が高く、耐磨耗性等に優れるため好ましい。被覆膜は少なくとも１層あればよいが、各層の厚さが２μm以下、特に１μm以下であり、全厚さが０．２～１０μm以下の複数の層からなるものであることが好ましく、各層の厚さが上記のような薄層であれば、高速の切削加工に使用した場合にも被覆膜が剥離することがない。また、最内層が厚さ１μm以下のAl_2O_3又はＡｌＯＮ層、最外層が厚さ０．５μm以下の窒化チタン層からなる被覆膜を形成すれば、Al_2O_3を主体とする焼結体との相溶性に優れるとともに、表面硬度が非常に高く、粒界ガラス相のない表面を有するセラミック切削工具が得られより好ましい。

【００１１】

【作用】浸炭焼き入れ鋼、ダイス鋼等の高硬度材を切削する場合、特に高速で切削加工する場合は、部分的に１０００℃以上の高温になる。そのため通常のセラミック工具では硬度及び強度等の急激な低下が起こり、激しい磨耗を生じたり、場合によっては欠損することもあり、工具寿命は短い。本発明では、特定の焼結原料に、特定量の焼結助剤を組み合わせることにより、組織を構成する大部分の成分粒子の平均粒径を１μm以下、好ましくは０．７μmとすることができ、硬度及び強度が非常に高いアルミナ系焼結体を得ることができる。また、この焼結体の表面に各層の厚さが２μm以下、好ましくは１μm以下の、少なくとも１層の被覆膜を形成することにより、母材への密着性に優れ、硬度、強度等の大きい被覆膜を有する高硬度材の切削工具用として好適なセラミックとすることができる。更に、本発明の焼結体と被覆膜とからなるセラミックを使用した切削工具は、上記のような高速切削において高温に晒された場合も、高い硬度及び強度が維持され、ＣＢＮ工具の切削速度域である１５０mm／分以上の切削速度であっても十分使用可能である。

【００１２】

【実施例】以下、実施例及び比較例により本発明を具体的に説明する。

(1) 焼結体の製造

① Al_2O_3成分：平均粒径０．５μmのAl_2O_3粉末、平均粒径０．５μmのZrO_2粉末、② 炭化チタン等：平均粒径１μmのＴｉＣ、ＴｉＣＮ、ＴａＣ、ＷＣ粉末、③ 焼結助剤：平均粒径０．２μmのＭｇＯ、平均粒径０．９μmのY_2O_3、Dy_2O_3粉末、以上の各成分を表１（実施品）及び表２（比較品）に示す割合で混合し、アトライターで強粉砕した後、圧力２００ｋｇ／ｃ

m^2、温度１７００～１８００℃でホットプレスした。得られた焼結体を所定形状に研削加工して、切削テスト用のチップを作製（実施品２、４、５及び７を使用）した。また、上記焼結体から切り出した試片により、焼結体の平均粒径、相対密度、硬度（測定方法：ビッカース硬度、荷重 10 Kgf ）、抗折力（測定方法：ＪＩＳＲ－１６０１に準拠）を測定した。それらの結果を表１及び２（各表中ＨＶは上記硬度を表す）に示す。尚、表２において＊は数値限定範囲外であることを表す。

【００１３】

【表１】

表　1

実施品	焼結原料（重量%）		焼結助剤（重量%）	平均粒子径（μm）	相対密度（%）	HV（kg/mm²）	抗折力（kg/mm²）
	Al_2O_3	その他					
1	85	TiC 15	MgO 1.0	0.7	99.5	2040	108
2	70	TiC 30	MgO 1.0	0.5	99.5	2150	113
3	55	TiC 45	MgO 1.0	0.4	99.2	2130	98
4	70	TiCN 30	MgO 1.0	0.4	99.6	2110	121
5	70	TiC + TaC 15 15	MgO 1.0	0.5	99.8	2180	124
6	70	TiC + WC 15 15	MgO 1.0	0.5	99.5	2090	113
7	70	TiC 30	MgO + Dy_2O_3 0.5 0.5	0.4	99.8	2210	131
8	70	TiC 30	MgO 4.0	0.9	99.8	1980	96
9	70	TiC 30	MgO 2.0	0.8	99.8	2030	103
10	55 + $ZrO_2$15	TiC 30	MgO 2.0	0.5	99.7	1950	108

【００１４】

【表２】

表　2

比較品	焼結原料（重量%）		焼結助剤（重量%）	平均粒子径（μm）	相対密度（%）	HV（kg/mm²）	抗折力（kg/mm²）
	Al_2O_3	その他					
1	* 95	TiC 15	MgO 1.0	1.5	99.9	1870	95
2	* 45	TiC 55	MgO 1.0	0.4	98.5	1830	74
3	70	TiC 30	MgO * 0.1	0.5	89.9	1560	52
4	70	TiC 30	MgO * 6.0	1.3	99.9	1740	84
5	15+ZrO_2 * 55	TiC 30	MgO 2.0	0.5	98.9	1710	97

【0015】表1の結果によれば、本発明のセラミック工具に使用される焼結体は、いずれもその全成分の平均粒径が1μm以下であり、相対密度が99重量%以上と高いうえに、硬度、抗折力ともに優れていることが分かる。特に焼結助剤の使用量が1重量%の場合は、使用量が2重量%以上の場合に比べて一層優れている。一方、表2の結果によれば、Al_2O_3又はMgOが上限を越えた場合（比較品1及び4）は、焼結体の全成分の平均粒径が1μmを越え、硬度、抗折力が劣り、また、MgOが下限未満の場合（比較品3）は、相対密度、硬度、抗折力いずれもが大きく低下しているのが分かる。その他の場合にも硬度、抗折力が低下し、比較品はいずれも本発明のセラミック工具を得るための焼結体としては使用できないものである。

【0016】(2) セラミック工具の製造

上記(1) で作製した切削テスト用のチップ表面に、表3（実施例）及び4（比較例）に示す被覆膜を公知のCVD法或いはPVD法によって形成し、下記条件で切削テストを実施した。

① 被削材：SCM415浸炭焼き入れ材（Hv=850～700 Kg/mm²）
② チップ形状：TNGN332
③ 切削速度：200m／分
④ 送り：0．1mm／rev
⑤ 切込み：0．3mm
⑥ チャンファー：0．2mm×－25°

上記条件にて被削材を30分間切削した後、平均逃げ面磨耗量（V_B磨耗量）を測定した。それらの結果を表3及び4に示す。尚、表4において＊は数値限定範囲外であることを表す。

【0017】

【表3】

表　3

実施例	使用焼結体 実施品No	被覆膜種類及び厚さ（μm） 内層～外層	全厚さ （μm）	V_B 磨耗量 （mm）	剥離の有無
1	2	Al_2O_3(0.2)+TiC(0.1)	0.3	0.18	なし
2	2	Al_2O_3(0.8)+TiC(0.8) ×5 層	8.0	0.17	なし
3	2	Al_2O_3(0.7)+TiC(0.7)+TiN(0.2)	1.6	0.15	なし
4	2	TiC(0.7)+ Al_2O_3(0.7)	1.4	0.17	なし
5	2	Al_2O_3(1.5)+TiC(0.7)	2.2	0.16	なし
6	2	Al_2O_3(0.7)	0.7	0.18	なし
7	2	TiC(0.7)	0.7	0.15	なし
8	2	TiN(0.7)	0.7	0.17	なし
9	4	Al_2O_3(0.7)+TiC(0.7)+TiN(0.2)	1.6	0.16	なし
10	5	Al_2O_3(0.7)+TiC(0.7)+TiN(0.2)	1.6	0.15	なし
11	7	Al_2O_3(0.7)+TiC(0.7)+TiN(0.2)	1.6	0.15	なし
12	2	Al_2O_3(0.7)+AlON(0.7)+TiN(0.7)	2.1	0.17	なし

【0018】

【表4　】

表 4

比較例	使用焼結体 実施品No	被覆膜種類及び厚さ（μm） 内層～外層	全厚さ （μm）	V_B 磨耗量 （mm）	剥離の有無
1	2	Al_2O_3(0.05)+TiC(0.05)	＊0.1	0.30	なし
2	2	Al_2O_3(0.8)+TiC(0.8) ×7 層	＊11.2	0.32	剥離大
3	2	Al_2O_3(＊ 3.0)+TiC(0.7)	3.7	0.32	剥離
4	市販品	TiN(1.0)(PVDコーティング)	1.0	0.40	剥離、折損

【００１９】表３の結果によれば、本発明のセラミック工具は、いずれも高硬度材の高速切削において、被覆膜が剥離することがなく、且つ、V_B 磨耗量が小さいことが分かる。また、最内層に厚さ０．７μｍのAl_2O_3を、最外層に厚さ０．２μｍのＴｉＮを使用した被覆膜の場合及び被覆膜がＴｉＣである場合は、特に耐磨耗性に優れていることが分かる。一方、表４の結果によれば、被覆膜の全厚さが下限未満のもの（比較例１）、上限を越えたもの（比較例２）及び１層の厚さが上限を越えたもの（比較例３）は、いずれもV_B 磨耗量が実施例の倍程度となっており、また、比較例２及び３では被覆膜の剥離も生じており、特に比較例２では剥離面積が大きい。尚、参考のため比較例４として同様に切削テストをした市販品では、磨耗量は本発明における比較例より更に多く、また、剥離ばかりではなくチップの折損も生じ、本発明のセラミック工具に比べ著しく性能が劣ることが分かる。

【００２０】

【発明の効果】本発明の高硬度材切削用セラミック工具は、セラミック本体の構成粒子の平均粒径が特定の微小粒子であり、また、特定の厚さの被覆膜を有するため、硬度及び強度に優れ、浸炭焼き入れ鋼、ダイス鋼等の高硬度材を高速で切削加工した場合にも、その優れた硬度、強度が維持され、ＣＢＮ工具の代替えとして使用し得るものである。